

Healthcare Technology, Patient Engagement and Adherence: Systems and Business Opportunity Analysis

By

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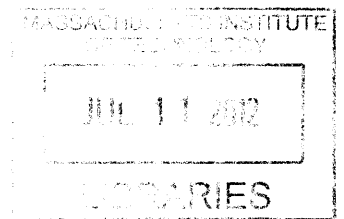
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Signature of Author

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TABLE OF CONTENTS

1	MEDICATION ADHERENCE ANALYSIS	7
1.1	BACKGROUND AND RECENT TRENDS	7
1.2	REASONS FOR NON-ADHERENCE	9
2	MEDICATION ADHERENCE AND DATA ANALYTICS: CURRENT TRENDS	11
2.1	CURRENT ADHERENCE AND INCENTIVE SYSTEM SOLUTIONS	11
2.2	STAKEHOLDER ANALYSIS	12
2.3	MEASUREMENT OF ADHERENCE	18
2.3.1	<i>Issues in Measurement of MPR</i>	<i>19</i>
2.4	THE ROLE OF DATA.....	20
2.4.1	<i>Data Sources</i>	<i>21</i>
2.4.2	<i>Data Analysis, Knowledge Generation and Application</i>	<i>23</i>
2.4.3	<i>A commercial example of using data for medication adherence.....</i>	<i>24</i>
2.4.4	<i>Analytics Using Consolidation of Electronic Health Record Data by Vendors</i>	<i>25</i>
3	CURRENT AND FUTURE HEALTH TECHNOLOGY TOOLS AND PLATFORMS: PATIENT ENGAGEMENT AND WELLNESS	27
3.1	STAKEHOLDER INCENTIVES	27
3.1.1	<i>Cost Reduction.....</i>	<i>27</i>
3.1.2	<i>Health Engagement and Behavioral Change.....</i>	<i>28</i>
3.1.3	<i>Operational Efficiency</i>	<i>28</i>
3.1.4	<i>Workforce Productivity Improvement</i>	<i>29</i>
3.1.5	<i>Patient Satisfaction</i>	<i>29</i>
3.2	CHANNELS.....	30
3.2.1	<i>Social - Wellness tools</i>	<i>30</i>
3.2.2	<i>Patient Information Sharing Communities.....</i>	<i>33</i>
3.2.3	<i>Mobile Health Applications and Services.....</i>	<i>34</i>
4	TECHNOLOGY BASED INTERVENTION IN A BEHAVIORAL CARE PRODUCT: A CASE STUDY	38
4.1	IMPACT OF MENTAL HEALTH PROBLEMS	38
4.2	THE VERITAS SOLUTION	39
4.3	STAKEHOLDER ANALYSIS	41
4.4	RELEVANT MARKET SEGMENTS	47
4.5	VALUE PROPOSITION.....	49
4.6	COMMERCIALIZATION ANALYSIS FOR THE PRODUCT	50
4.6.1	<i>Determining the Economic Value to the Customer (EVC)</i>	<i>52</i>
5	FUTURE POTENTIAL: ADOPTION, REGULATION AND BEYOND	54
5.1	CONSUMER FOCUSED HEALTH INNOVATIONS AND THEIR ADOPTION DYNAMICS	54
5.2	ADOPTION CONSIDERATIONS FOR MOBILE PLATFORMS	57
5.3	ADOPTION FROM THE PROVIDER'S POINT OF VIEW.....	58
5.4	REGULATORY CONSIDERATIONS	59
5.5	WHAT NEXT: FROM A BODY-MIND CENTRIC HEALTHCARE PERSPECTIVE TO BEYOND?	62
6	REFERENCES	63

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Abstract

In the current shift in the US healthcare system, lower cost, higher quality of care, access and safety are the main drivers that are effecting changes. Patient compliance with medication and technology enabled wellness and engagement programs play an important role in ensuring the cost and quality of care is reduced. In a recent study, the overall cost of poor medication adherence, measured in otherwise avoidable medical spending, is close to \$310 billion annually, representing approximately 14% of total healthcare expenditures.

There have been several studies analyzing the reasons for and impact of non-adherence and solutions to achieve increasing compliance. With the recent wave in healthcare technology, the scope of prescription medication adherence needs to be expanded to include patient engagement and their awareness towards lifestyle changes and managing their own health. This thesis engages in an analysis of these compliance issues and in understanding the relationships among the various stakeholders involved. It also analyses the several technology platforms and solutions from mobile health to “gamification” and social networks from a business, user and regulatory standpoint. It looks into how these newer health technologies helps the individual in adhering and realizing novel insights into their own patterns related to medication, lifestyle and general health. Further, working with a health technology startup catering to the behavioral care market, a real world application of a health technology product that utilizes technology based patient assessment, decision support and patient communication, will be evaluated to explore how it will help in delivering value to several stakeholders.

1 Medication Adherence Analysis

1.1 Background and recent trends

Low medication adherence has implications in several areas. Over 2000 years ago Hippocrates warned physicians to “keep watch also on the faults of patients which often make them lie about the taking of things prescribed”. Today, within the healthcare community, medication non-adherence is recognized with its wider impact not only on the patient, but also on the multi-level systemic areas. The New York Times calls non-compliance the world’s “other drug problem”.

Poor adherence is a striking global problem in healthcare. Several studies have shown that global patient adherence rates, especially those suffering with chronic conditions, average around 50% (WHO, 2003). In the US, a recent survey (National Council on Patient Information and Education, 2007) showed that 49% of respondents admitted to have forgotten a prescribed medicine, 31% of respondents had not filled a prescription they had been given, 29% of respondents had stopped taking a medicine before the supply ran out and 24% of respondents had taken less than the recommended dose.

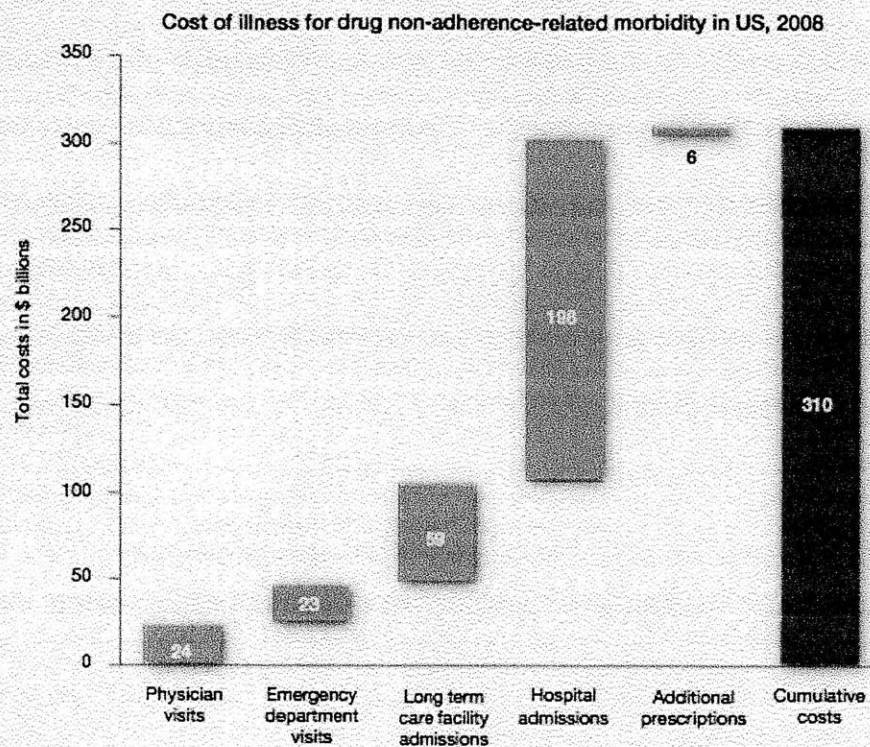
The direct result of these challenging low adherence levels is a high cost of healthcare and poor health care outcomes, as the first order effects. Figure 1 shows the cost of non-adherence to the US healthcare system. With a total cost impact of more than 300 billion contributed mainly by hospital admissions.

Patient non-adherence leads to significant costs for the healthcare system

Poor adherence leads to poor health outcomes and increased healthcare costs for healthcare systems and authorities.

Research conducted by the New England Healthcare Institute (NEHI) in 2009 estimated that, in the US, the overall cost of poor adherence, measured in otherwise avoidable medical spending, is close to \$310 billion annually, representing approximately 14% of total healthcare expenditures⁹ (Figure 3).

Figure 3: Cost of patient non-adherence to the US healthcare system



Source: "Thinking outside the pitbox"

Figure 1: Cost of Patient non-adherence in the US

Source: Capgemini Consulting, "Patient Adherence: The Next Frontier in Patient Care", (Capgemini Consulting, 2009)

Non-adherence as such is complex and multidimensional issue with a very high impact on the healthcare system in terms of health of individuals and the cost burden on the already strained and complex healthcare system. To make matters

even more serious, the number of stakeholders compounds the pathways to find a solution to the problem.

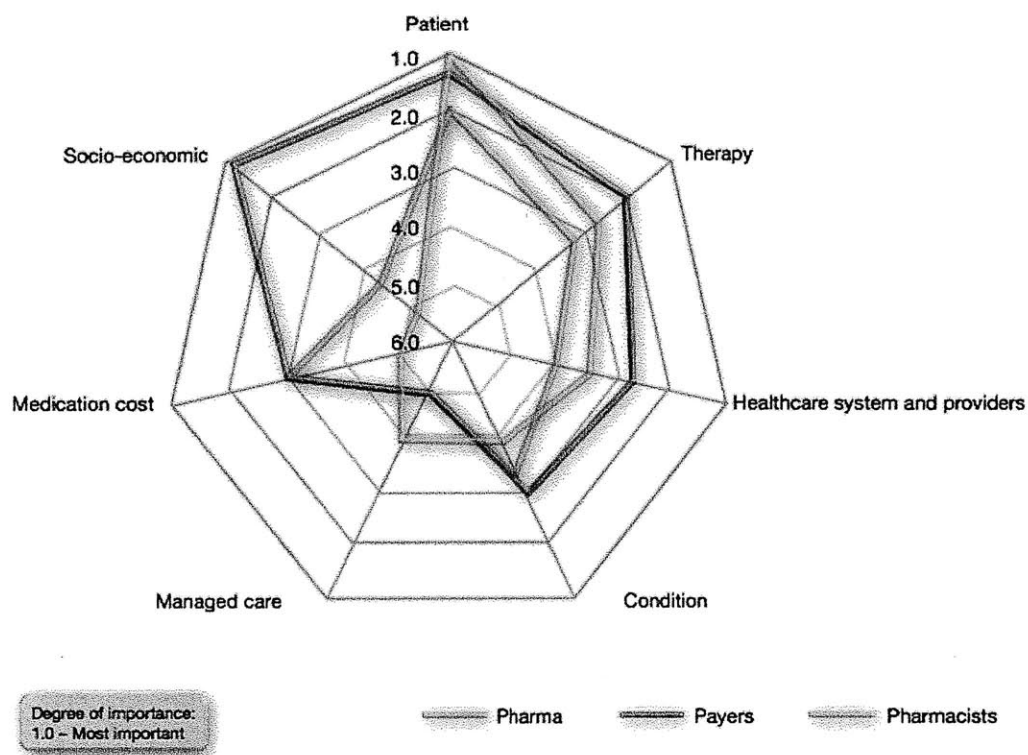
1.2 Reasons for non-adherence

Factors non-adherence spans across finance, behavioral, social, health and information domains. While the ranking of the reasons for non-adherence vary according to several studies (AstraZeneca Study, 2008), the top four reasons found are highlighted in Table 1. A combination of these reasons in practice seems like the most likely cause for non-adherence.

Financial	Behavioral	Social	Health	Informational
Affordability	Forgetfulness	Lack of family/ social support	Unwanted side-effects	Lack of disease or treatment information
	Feeling that drug is not needed	Cultural	Low drug satisfaction	Lack of prescribed drug information
	Poor relationship with self or provider			
	Lack of concern over condition			

Table 1: Adherence Cause Matrix

These reasons vary across socio-economic segments of society, age, condition, provider-related and cultural factors. Interestingly, the importance attributed by the various stakeholders with respect to the factors that drive adherence varies. This is clear from Figure 2.



Source: Capgemini Consulting

Fig 2: Ranking of factors driving adherence across stakeholders

Source: Capgemini Consulting, "Patient Adherence: The Next Frontier in Patient Care", (Capgemini Consulting, 2009)

While there is a definite trend among a targeted group of major stakeholders for each of the factors, such as ranking Patient and Therapy related ones as those driving adherence, Socio-economic factors is clearly one that payers rank much higher than pharmacists or pharmaceutical companies. The probable reasons for this may be availability of bulk data that drives the parameters of their insurance plans, which are based on the correlation of affordability and demographics.

2 Medication Adherence and Data Analytics: Current Trends

2.1 Current adherence and incentive system solutions

Since medication adherence is a multi-dimensional phenomenon, the mechanism to tackle it needs a targeted approach, often evidence driven. Profiling patients with high risk of non-adherence is a key measure that is beginning to get employed with the availability of patient and prescription data.

Tables 2 and 3 show the several systems of adherence and incentive systems that are implemented to help in compliance.

Medication Adherence System	Description	Examples
Devices	Devices used for helping adherence and to track compliance	Senticare, Dose-alert, McKesson - HealthBuddy
Software Services	Software/mobile apps for reminders and compliance tracking.	Microsoft HealthVault CommunityConnect, iGetBetter.com, Ginger.io
Education	Doctor Education, Behavioral Health, Community Support	PatientsLikeMe
Reminders (Proactive Intervention)	Call from care team (provider, case mgmt., home care etc.) to check and remind. Studies show home delivery of medication helps improve adherence by 15%.	ScriptYourFuture Initiative

Table 2: Medication Adherence Systems

As we can notice, there are several adherence systems and in everyday implementation a combination of these is most effective. A mobile application that provides reminders and at the same time alerts the care team of anomalies is one such example. In terms of incentive systems, these are essentially of only two types: financial and behavioral/social. Financial ones are essentially driven by payers and pharmaceutical companies, whereas the behavioral/social applications and platforms are driven by payers that also include self-insured employers. This is discussed in-depth in Section 3.2

Incentive System	Description	Examples
Financial	Co-pay discounts,	<ul style="list-style-type: none"> • McKesson Loyalty Script (Co-pay discounts) • Lottery
Behavioral/Social Gaming	Social norming, gaming	<ul style="list-style-type: none"> • Keas.com • HealthMedia.com

Table 3: Medication Adherence Incentive Systems

2.2 Stakeholder Analysis

Medication and wellness plan adherence is an issue that has multiple stakeholders with complex relationships among them that comprise the fabric of this system.

The key stakeholders would generally include:

- Providers

This would include physicians, hospitals, nurses and other caregiving individuals and institutions.

- Payers

Payers consists of public (federal government programs such as Medicare and Medicaid, military insurance other state and local programs), private health insurers and the largest component, employer funded insurance.

- Patients

For the purpose of our analysis, patients are all those who are under care of a provider as well as those who are voluntarily engaged in wellness and lifestyle programs and services.

- Pharmaceutical and Medical Device Companies

Prescription drug and medical device manufacturers licensed for use as medications.

- Pharmacies

Entities that traditionally compound and dispense medication as well as involved

in reviewing medications for safety and efficacy.

- Pharmacy Benefit Managers (PBM's)

Pharmacy Benefit Manager (PBM) is a third party administrator (TPA) of prescription drug programs. They are primarily responsible for processing and paying prescription drug claims. (Pharmacy Benefit Management, 2012)

- Government Health Agencies

These would generally include agencies that collect data, analyze it, devise policies and programs, provide healthcare assistance in local settings (such as community health centers)

- Third Party Healthcare Technology Service/Product Vendors

In the current upsurge in healthcare technology, this stakeholder would include all those who provide technology based services and products towards collecting data through software or devices, analyzing it, storing and delivering it to other stakeholders. The primary service of these vendors include, presenting meaningful insights from the data. Several health technology products including Electronic Health Records, mobile applications, clinical decision support systems are few examples.

- Hospital Patient Support

Case management staff in hospitals who are key individuals in transitioning care

of patients in inter-provider and hospital to home settings. These become important especially in patient communication and tracking adherence.

System Dynamics is a great methodology that will help us in analyzing these relationships and how they affect each other. Also, it will allow us to predict the dynamics of several players and unearth hidden insights from this complex system. Fig 3 shows a representation of the system dynamics model using a stock and flow causal diagram.

In simple terms, stock represents the state of any entity that accumulates or depletes over time. The flow is the rate of change in a stock.

Pharma Company Revenues: Revenues from pharmaceutical companies is a direct function of the rate of adherence of patients to medication. This makes them a major stakeholder in this system.

The recursive loop **“Increased Patient Reporting”** represents the relationship between the number of individuals adhering to a prescribed regimen or those using wellness plans, which is reflected in the variable, and their use of technology services or products geared towards remote patient communication and care. This in turn helps in increasing the adherence rate.

Increasing numbers of adhering patients also increases relevant data fed through several sources represented by **“Adherence Data”**. This data forms the backbone of providing relevant incentives, education and other services to the stakeholders as described in section 2.4. Increasing data helps in refinement and innovation of these services based on analytics, which further help in increasing the adherence rate. This forms the recursive feedback, which would help in increasing patient adherence. An increase in the number of adhering patients also would lead to better patient health outcomes, which lead up to another loop.

“Positive Health Outcomes” leads to increased productivity and cost reductions for the several types of payers, which further incentivizes them to support technology products, which increase the adherence rate, this forms the **“Payer Encouragement”** recursive loop. Similarly payer incentives increase the

use of patient communication technologies further helping cost reduction for providers (such as due reduced staff requirement for billing and other patient support) which induces providers to support patient engagement technologies. This dynamic is indicated by the **“Provider Push”** recursive loop.

“Pharma Diminishing Returns” form the balancing loop, which is a result of **“Positive Health Outcomes”**. This would result in less patients needing any prescription medications or compliance to any wellness plans. The combined effect of decrease in the total patients under care, with the added effect of increase adherence rates would result in a drop in drug sales. This would cause less investment support by pharmaceutical companies towards adherence services and products. Since pharmaceutical companies are a major stakeholder, their support is critical. A drop in drug sales would lead them to re-invest their resources away from adherence promotion to other avenues expected to drive increasing company value.

2.3 Measurement of Adherence

While there are several ways to measure adherence, the Medication Possession Ration (MPR) appears to be a popular metric. It is essentially the ratio of the total days the member had drug available to the number of possible days the participant could have drug on hand.

To illustrate the calculation of the MPR (Kevin T. Stroupe, Evgenia Y. Teal, Wanzhu Tu, Michael Weiner, & Michael D. Murray, 2006), suppose a prescription

was filled on September 30, with the next refill expected on October 30. If the patient obtained the next (actual) refill on October 30, then the MPR would be 1.0 (30 expected days between refills divided by 30 actual days between refills), indicating the new refill was obtained just as the patient ran out of drug. If the patient instead received the next refill on October 15, then the MPR would be 2.0 (30 expected days divided by 15 actual days), indicating the patient obtained twice the supply needed over that period. If the patient obtained the next refill on November 29, then the MPR would be 0.5 (30 expected days divided by 60 actual days), indicating the patient obtained half the supply needed over that period.

2.3.1 Issues in Measurement of MPR

Even as MPR may give an idea of the adherence levels of an individual, there are certain issues in the methodological choices (Brenda Motheral) made in the calculation of MPR. In the MPR formula, if the denominator is taken as the entire period where the treatment discontinuation and gaps (time between depletion of one claim and the refill) is taken into account the MPR tends to be lower, whereas if only the gaps are taken the MPR becomes higher.

Further, comparing MPR's can be illusive for two reasons:

- 1.) Comparing them between vendors who report it for different time periods (multi-year versus quarterly) will give results that are related to the persistency of medication (the duration of time from initiation to discontinuation of therapy)

which is higher for shorter periods than longer.

2.) MPR is closely related to the whether the patient is new or ongoing. It has been found the persistency is lower for newer patients compared to those who are are being measured over a longer time. For a fixed time period this would tend to lower the MPR for newer patients.

2.4 The Role of Data

As we have seen in the previous section tracking and measuring adherence requires reliable data. The data can be gathered from a variety of sources spanning the range of stakeholders. This data forms the gold mine of information from which knowledge is gathered on demographic, health, lifestyle, adherence, comparative effectiveness of drugs, efficacy of public health initiatives, early warnings on epidemic outbreaks etc. Fig 4 provides and virtual architecture of the sources of data and their uses.

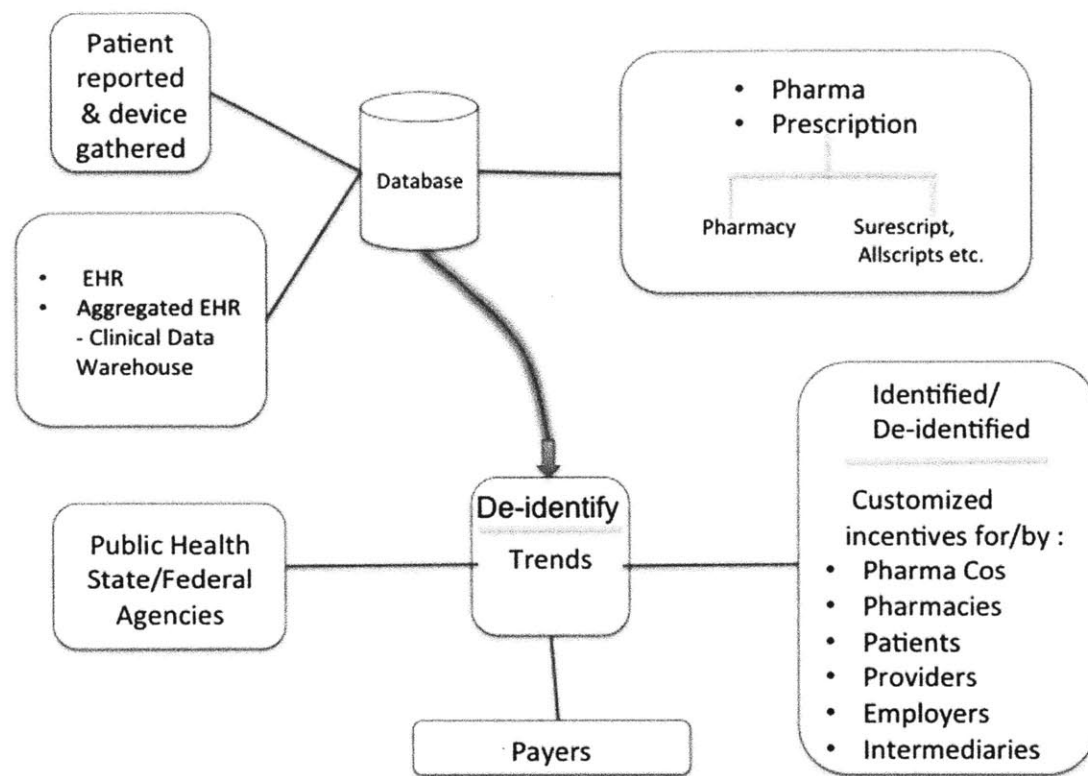


Fig 4: Health Technology Data Landscape

2.4.1 Data Sources

1.) Patient Reported and Device Gathered

This refers to the data gathered with an active input by a patient or a passive one. An example of self-reported information could be that provided by entering vital signs such as blood sugar level or pain level, miles walked and medication taken into a web based service.

With the increasing use of Near Field Communication (NFC) in mobile phones, gathering health, behavioral and wellness data becomes close to being as non-intrusive as possible for the subject.

The type and regularity of data obtained from patients is increasingly becoming a new type of data source capable of giving information that was previously simply unavailable for analysis. Further analysis of patient derived data is discussed in section 3.2

2.) Electronic Health Record (EHR) and Hospital Data Warehouse Derived

EHR and data derived from Hospital information systems form a large part of patient data. Aggregated data stored in a data warehouse (a database specifically designed for efficient retrieval and analysis of data), implemented increasingly by hospitals, form a data source that provides a more comprehensive set of data.

3.) Prescription Related and Pharmaceutical Manufacturers

Data gathered from prescriptions form the most significant source for gathering information specifically about compliance of prescribed medication. Pharmacies and prescription networks are the best entities for gathering information on prescriptions and trends. The information that is typically found would include, among other demographics, age and prescription information.

2.4.2 Data Analysis, Knowledge Generation and Application

Data analytics and, more so analytics of datasets that are orders of magnitude larger than traditional ones (understood as “Big Data”), is becoming extremely relevant in the healthcare context. Timely and synchronous analysis of these voluminous datasets with a heterogeneous mix of structured and unstructured data types (text, video, audio, log files etc.) can provide tremendous insights which would otherwise remain hidden.

In the medication adherence context, this knowledge generation from the combination of data does not limit one to adherence alone, but rather to a wealth of insights for every stakeholder in the healthcare landscape. De-identified patient data could be used for potentially unlimited applications, such as learning about lifestyle, behavioral and social relationships, drug efficacy and comparative effectiveness. The data also provides information that is relevant in the business context for pharmacies, drug distributors and pharmaceutical manufacturers. Identifying patients with high-risk of non-adherence, using the consolidated data in predictive models has been found to be extremely useful in determining the right incentives and communications increasing adherence. The correlation among these applications and the knowledge they deliver make healthcare ‘Big Data’ analytics the next frontier, with unlimited possibilities. Reducing healthcare costs, increasing safety, spurring technology innovation, growing businesses and learning about nuances in human behavior are some of the broad areas that current and future efforts seem to be focused on.

2.4.3 A commercial example of using data for medication adherence

In June 2011, the FICO® Medication Adherence Score was announced by FICO (FICO Press Release, 2011), the company that measures credit with its trademarked credit score. Instead of measuring how an individual borrows and repays money, it measures how well a drug prescription is handled. The more adherent an individual is to a prescription the higher will be their score. The score is intended for providers, insurers and pharmaceutical companies to remind, educate and provide incentives to persons with lower adherence.

For the creation of the proprietary scoring algorithm with a score that ranges from 1 to 500, FICO took data of several million de-identified patients provided by a large pharmacy benefits manager (Simon). They observe the patients who filled the prescription with those who didn't and identified the variables that best predicted adherence. These variables include data such as age, family size, assets, such data that are also used by marketing companies.

This commercial use of data for FICO scoring exemplifies the analysis in a structured manner and the use of data for adherence, as well as measuring it for use by the primary stakeholders to curtail costs. Pharmaceutical companies clearly have higher revenue potential as a key benefit from knowing adherence potentials of their drugs.

Applying the FICO score or other such metrics to measure prescription medication adherence lead to several questions on how this information will be used and shared. Privacy seems to be leading this list of concerns, with patients not knowing with whom this data will be shared. A possibility could be, use by payers who could discriminate against them for low scores in the future when the FICO has been validated as an underwriting tool. Further, the combination of any or all of the uncertainty in medical conditions, affordability of large medical expenses and sudden change in one's economic condition can have a drastic impact on the score. Compared to credit scores, where one can have disciplined borrowing and debt repayment, commercialized adherence metrics may not take into account contingent medical situations, which makes rectification of these metrics challenging.

2.4.4 Analytics Using Consolidation of Electronic Health Record Data by Vendors

EHR vendors, with a large market footprint, such as GE's Medical Quality Improvement Consortium (MQIC) use the de-identified data from their installed base of EHR's for analytics. Users of their EHR's who participate in the program (nearly 20,000 providers) contribute to the approximately 20 million patient records (GE MQIC). The benefits to the providers include comparative performance against benchmarks for quality improvement. Quality reporting is also done on behalf of the providers for pay-for-performance programs such as the federal government's Patient Quality Reporting System (PQRS). This

valuable database is also used for population research projects, reporting epidemic outbreaks such as during H1N1 influenza activity.

3 Current and Future Health Technology Tools and Platforms: Patient Engagement and Wellness

As we have seen in Table 1 prescription medication adherence systems include Health IT systems that include standalone, Software-as-a-Service and mobile-based solutions. These systems take us to the other side of adherence beyond a typical view of prescription medication adherence towards adhering to lifestyle and positive health choices.

3.1 Stakeholder Incentives

From this perspective, the incentives for the stakeholders are based on cost reduction, health engagement and behavioral change, operational efficiency and workforce productivity improvement factors.

3.1.1 Cost Reduction

The driver in reducing costs applies to several stakeholders but mainly to payers, which could include private insurers and self-insured employers. Payers are increasingly investing in programs that help participants in taking responsibility for their health. The use of patient communication technologies, wellness tools and self-diagnostic services are some of the leading methods being employed to help participants achieve their health goals, which subsequently help in reducing costs.

3.1.2 Health Engagement and Behavioral Change

Public health agencies and non-profit organizations' use of technology solutions for education contribute to achieving their health and wellness targets towards improvement of their target population. These solutions include using several communication channels including mobile text messages, emails, interactive voice and mobile applications to educate individuals on specific health goals, addiction cessation, making healthy lifestyle choices and also encouraging medication compliance. A service such as Voxiva is an example of this type of solution, which uses these communications channels for educating and interacting with patients with diabetes, helping smoking cessation and for maternal health. It also provides the data to health agencies to monitor and derive insights from these programs.

3.1.3 Operational Efficiency

Health technologies and systems could offer a great solution in reducing the burden that is placed on health providers due to a shortage in trained physicians and facilities. We discuss, in a case study in Chapter 4, one such system that uses a stepped care and patient communication model in the behavioral healthcare space. This solutions aims to reduce the burden on psychiatrists by referring only those patients who need urgent care to them and having others in a graded model referred to nurse practitioners or through web or IVR telephone support. These types of systems provide not only increase access to the most needy patients but also reduce costs for the insurers as well as for the provider

by optimizing their resources further with the use of patient communication technologies.

3.1.4 Workforce Productivity Improvement

Employers use wellness programs to help reduce their health insurance costs. Data shows that these programs are also of value when enhancing productivity is taken into account. According to Dr. Pawel Suwinski, at *Frost & Sullivan* only 31% of healthcare expenditure in organizations is spent on direct medical costs, whilst 69% of medical costs are due to productivity loss. With the use of technology solutions, employees' stress levels are managed and subsequently any depression or co-morbid depression is also well managed. As is being shown by studies (The HR Specialist: Compensation and Benefits, Oct 2008), this not only helps in the maintenance of better employee health but also results in overall productivity gains.

3.1.5 Patient Satisfaction

Patient portals are increasingly employed by physician practices as well as large health systems to make it easier for patients to not only communicate better with their care team but also make their visits into and out of the provider seamless.

Providing patients with forms or information before their visit, lab results, reminders, detailed billing and after visit summary are some features that these patient portal platforms offer. According to the 2011 Intuit Health survey "patients

increasingly want online access for their healthcare information. 72 percent of respondents between the ages 18-65 said they would use an online tool that would help them communicate with their doctor more easily, make appointments, get lab results and pay their medical bills.” Patient portals are essentially multi-sided technology platforms which are integrated with the providers systems such as EHR’s etc. and could be further enhanced by 3rd party services such as patient communities, SMS communication services and other relevant products. Their use in ACO’s makes their data integration capabilities much more relevant.

In all of these wellness based technology solutions, there are three themes that dominate the patient communication aspect – Education, Incentives and Engagement. How these are weaved together is discussed below through the various channels.

3.2 Channels

The health technology systems that we discussed can have in general the following three major delivery channels based on the stakeholder incentives and the market segment.

3.2.1 Social - Wellness tools

These are tools that provide online platforms that engage, educate and provide a forum for participants that encourage them towards their health goals.

According to the 2011 Willis Health and Productivity Survey of employers, 60% of respondents indicated they have some type of wellness program, an increase of 13% from 2010. Wellness programs are continuing to evolve, as more data on efficacy is available and technologies channels such as mobile health and social networks offer services that integrate participants' lifestyle with the engagement and behavioral change goals of these platforms.

In general, wellness tools offer a lot of value to self-insured employers in terms of reducing cost and improving productivity. From a higher-level perspective of the healthcare system, corporations bear approximately 25% of the total nation's health expenditures in the US.

There are several offerings by insurers as well as private enterprises that offer wellness programs. An example of those offered by private players include Numera|Social and Keas. Participant engagement, incentives and education are the key drivers as we mentioned before. Numera|Social has innovated a different model wherein they integrate the wellness program as an application into the Facebook social network instead of a platform that has their own social network. In the interview with their Vice-President of Product Management at Numera Health, Bill Reid says the company's strategy is to integrate the interaction of the participants within the program with the most prominent online interactions. Use of targeted incentives increase wellness program participation by 60%, according to the Incentive Research Foundation. The hypothesis is that

a 'siloed' mobile application or internet platform affects the participation and reduces the behavioral incentives offered by the limited social network offered in such a system. With the popularity of Facebook, the company argues that offering a application within it gives participants the best of the ability to choose who they would want to collaborate and share with in a larger network as well as integrate the platform in their daily outside-of-work lives. It is assumed that this would help in increasing participation even more and offers greater choices on who the participants would want to "compete" in online lifestyle games – using "gamification" techniques. Companies that would want to exclude having their wellness platforms as an application on Facebook for privacy reasons would remain off-limits for such a model.

Gamification techniques offer participants incentives and empower individuals to adopt and maintain health lifestyle habits. The company Keas offers programs with gamified incentives. The program allows participants with an opt-in competition software platform, where individuals or teams earn points by completing lifestyle and health related tasks or challenges. Winners earn badges and prizes, ranging from cash to gifts. Winners earn badges and prizes, ranging from cash to gifts.

Game mechanics, social networking, rewards and team-based support provide participants a great mix in reaching their health objectives in addition to being entertaining. The health engagement provides employees with insights and

comparison of their progress with the network. As a secondary effect it induces the participants to learn more about their lifestyle choices and adjust them for better outcomes.

3.2.2 Patient Information Sharing Communities

These are online platforms that do much like the social-wellness but for the business model and the emphasis on sharing information about the members' medical conditions, side effects and being a resource for medical knowledge. These platforms are essentially driven by members who main incentive is to share their knowledge and experience and the same time learn from other members' experiences. Patientslikeme, founded by MIT graduate Heywood brothers and a company which is at the forefront of these community platforms also have members who could sign up for clinical trials based on their conditions. Their business model is based on sharing member data with the several stakeholders in the healthcare fabric.

The wealth of data that is shared by individuals in such communities offers a perspective that hitherto was simply not available. This includes clinical and lifestyle related data. For example a lot of knowledge could be gathered on how patients use drugs, when they stop, their side effects and could be used to draw correlations. These observational trials give a totally different aspect as to how intervention works in the real world by including those patients who otherwise

would have been eliminated from structured clinical trials, which may not reflect the actual patient profiles.

The possible challenge in these platforms could be maintaining the incentives for users to participate regularly and sign-in into their condition tracking programs, as well as reaching out to larger spectrum participants such as those similar in age and other demographics.

3.2.3 Mobile Health Applications and Services

Mobile health or 'mHealth' as it is popularly known is increasingly becoming a significant integrator of the several offerings and channels of patient communication, engagement, education and data gathering.

According to the Consumer Health Information Corporation (CHIC) survey (mobihealthnews, 2011) 91.1% of survey respondents said they wanted an app that provided them with health information, while 58.4 percent would like to manage a health issue via mobile. 48.5% said they wanted to track their own health. About 79% said they would be more motivated to use an app that analyzed their data and provided feedback. While tracking data might be exciting, a large portion of survey takers wanted apps to find information on drugs (42%) or disease (26.5%). About 40% of survey respondents would use a health app multiple times a day.

It is becoming increasingly clear that with the increasing adoption of smartphones (about 50%), according to Nielsen Mobile Insights 2012, a 14 percent point increase from the year before, the use of healthcare related mobile apps signals a shift in the way individuals consume and share information in the patient-provider-payer setting as well with others in a social network.

Fig 5 provides a high level perspective of the mobile health landscape.

Essentially, as we see in Table 4, mHealth apps and services fall into four major categories.

mHealth App/Service	Description and Examples
Patient Communication	Application that range from provider communication and alerts, such as something in the patient report to appointment billing and billing.
Wellness	Wellness related applications reflect the need to track lifestyle habits and modify them through insights and incentives. Typical application involve those related fitness, sleep and nutrition tracking and stress.
Data Collection	From a patient care, medication adherence and care plan tracking perspective, data availability carries prime importance. mHealth applications that use diagnostic devices that could be connected to smartphones or those that use Near Field Communication or user provided data such as adherence are some examples. The analytics performed on such data increases the value of these apps to the users provides an incentive for greater participation.
Behavioral, Informational and Educational	Health information is one of the top most searches on the internet. Availability of such data on a smartphone & sharing it in a social network provide behavioral incentives. A good example would be programs such as smoking cessation, which provide timed personal challenges that could be shared among the users' network.

Table 4: Mobile Health Application/Services – High Level View

The relevance of all of these channels to medication compliance or a wellness program is connected by the ability of all of them to track patient behavior. Accessing patient medication patterns at a more granular level, as well as

encouraging the participants of these programs through behavioral incentives in a social network, provides promise for increasing their adherence levels.

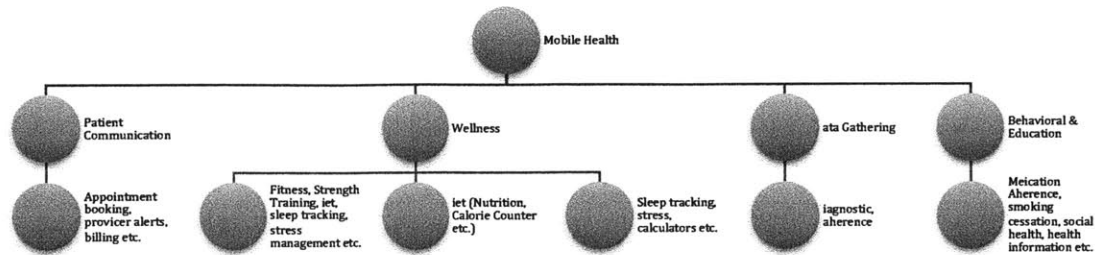


Fig 5: Mobile Health Landscape

From the perspective of other stakeholders, these technologies provide healthcare providers and researchers access to such data and at such a scale simply not previously available to them. Redirecting these insights back to the patients help them in making positive lifestyle choices

At least 50% of medical costs are preventable by lifestyle adjustments, and 75% of all medical costs caused by chronic diseases are best prevented and treated by lifestyle adjustments (Frost & Sullivan, 2010). These cost advantages, in turn, help the payers, providers and government health agencies in reaching their financial or policy metrics.

4 Technology Based Intervention in a Behavioral Care Product: A Case Study

Several studies (Kessler D, 2009) (King VL, 2009) have shown the remarkable efficacy of computer based remote mental health therapy over that in regular primary care. Veritas' solution provides a practical application of a technology-based solution using Cognitive Behavioral Therapy, invented by a group of experts including psychiatrists, technologists and business strategists at Veritas Health Solutions (Veritas).

The main concept of this solution revolves around technology-supported selfcare in the behavioral health care space and includes the following:

- Real-time measurement of status, risk assessment and feedback
- Automated stepped care (resource matching)
- Tailored therapy

Among the other benefits to the target user and buyer, this solution would help in clinical decision support, keeping communication with patients and help them in adhering to medications and care plans.

4.1 Impact of Mental Health Problems

Mental health problems are common, under-recognized, under-treated and costly. Among the several effects of this, it leads to:

- High resource utilization due to the multiple undiagnosed physical symptoms which confound medical diagnosis
- Poor medication adherence and general low interventions to treat this
- Loss of employee productivity
- Increased risk of substance abuse
- Lifestyle risks (such as sedentary behavior, poor nutrition and obesity)

4.2 The Veritas Solution

Fig 6 gives a high-level design of the solution. To understand the application of this system in a real world setting, let us take the example of a patient who feels she is depressed and engages this system. A sample flow will look something like this:

1. She will enroll and provide her symptoms or conditions using Interactive Voice Response or web-based interview conducted by a trained professional for gathering data for her condition assessment.
2. The responses provided by her will be fed into a multi-source database that integrates data from multiple sources related to her. For example, it could include a provider database on her prescriptions, adherence, and symptom monitoring. In large hospitals, a data-warehouse could be linked.
3. This aggregated data is then given to the Resource Intensity Treatment Adjustor (RITA™), which is the proprietary algorithm that determines the level of care that is most appropriate for the patient.

4. The decision point here is whether she needs a behavioral health referral or not. If she does, the level of care is determined, for urgent care (example: high suicide risk) a psychiatrist would be alerted and for non-urgent care a nurse practitioner. If she does not need referral, the technology supported self-care model will assist her.

The solution spreads the demand on providers across several levels in terms of the type of care provider as well as the type of care required. At a high level, this directly helps in reducing the burden on the provider and increases access to patients as well reduces cost for the payer due to reduced reimbursement rates for treatments that are not given by the psychiatrist.

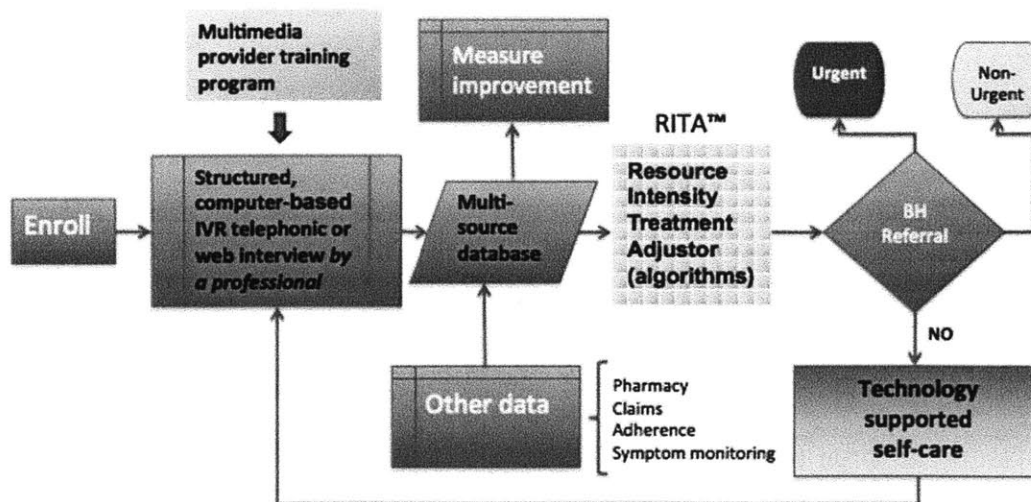


Fig 6: Technology Architecture of the Veritas Solution

Source: Veritas Health Solutions (Steve Locke, 2011)

4.3 Stakeholder Analysis

From a business perspective, the applicability of these solutions relates to several stakeholders in healthcare, with providers, payers and patients being the most closely related ones. A comprehensive stakeholder analysis was done by Veritas to identify and lay out the value proposition for each of them. This was an initial step to further analyze and point out who the primary stakeholders would be and move towards finalizing the target market segments for commercialization of the solution.

As we see in Table 5, the number of stakeholders is large. From a strategic standpoint the applications of the solution for a stakeholder or a set of stakeholders would make the most sense where there is a large untapped market and where go-to-market strategies are readily implementable. Towards these objectives, preliminary analyses revealed two possible applications of the technology as discussed below.

Stakeholder	Value Proposition
Payers – Insurance Cos.	Reduces costs.
Community Health Orgs.	Improves patient outcomes and satisfaction, better ability to track patients, personalized, improves quality and oper. efficiency thro' CDS and analytics.
Care Management	Improves patient outcomes and satisfaction, better ability to track patients, personalized, cost improves quality and oper. efficiency thro' CDS and analytics.
Integrated Health Ntwks	Improves patient outcomes and satisfaction, better ability to track patients, cost , personalized, improves quality, oper. efficiency - CDS & analytics.
Student Health Services	Improves patient outcomes and satisfaction, better ability to track patients, improves quality and operational efficiency. , improves quality, cost , personalized, improves quality, oper. efficiency - CDS & analytics. Better school perception.
Military/Veterans Health	Improves patient outcomes and satisfaction, better ability to track patients, cost , personalized, improves quality, oper. efficiency - CDS & analytics.
Disaster Relief Orgs.	Improves patient outcomes and satisfaction, better ability to track patients, cost, personalize improves quality, oper. efficiency - CDS & analytics.
Self-insured Employers	Productivity gains and cost reduction. Remote patient coordination
Physicians	Higher patient satisfaction and quality.
State Health Agencies	Data on patient compliance and comparative and clinical effectiveness fed through Health Information Exchanges
Disease Mgmt. Vendors	Ability to interface and bundle thereby increase sales volume

Table 5: Veritas Stakeholder Analysis

1. Co-Morbid Depression

This term refers to the depression that occurs in the presence of physical illness, usually of a chronic nature. Features of depression typically include (Jones, 2012):

- sleep disturbance;
- loss of interest in everyday things such as hobbies and family;
- inability to look forward to things;
- loss of self esteem; and
- change in appetite.

People who have conditions that produce a lot of pain, restriction of activity or a poor outlook are all prone to developing depression on top of their existing illness. This depression then tends to further exacerbate the chronic conditions, such as asthma, diabetes or congestive heart failure (CHF).

Fig 7 shows a significant increase in the costs per member per month (PMPM) of various chronic conditions for an individual with depression.

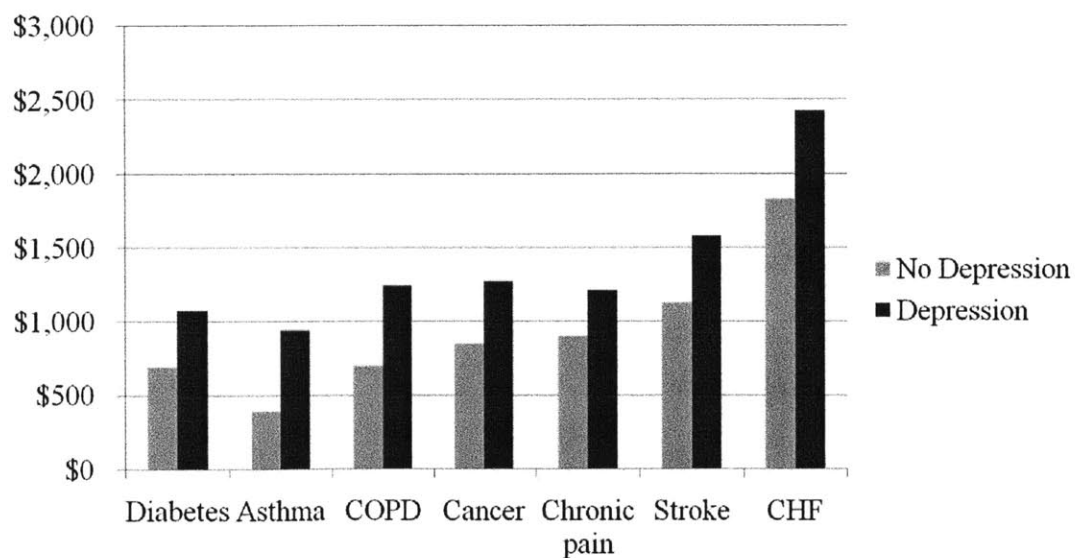


Fig 7: Comparison of medical costs PMPM for co-morbid depression

Source: Milliman Research Report. Chronic conditions and co-morbid psychological disorders, July 2008.

The higher cost of treating patients with co-morbid depression is particularly impacting payers (such as self-insured employers and health insurance companies, as well as Medicaid and Medicare) in terms of their overall increase in costs.

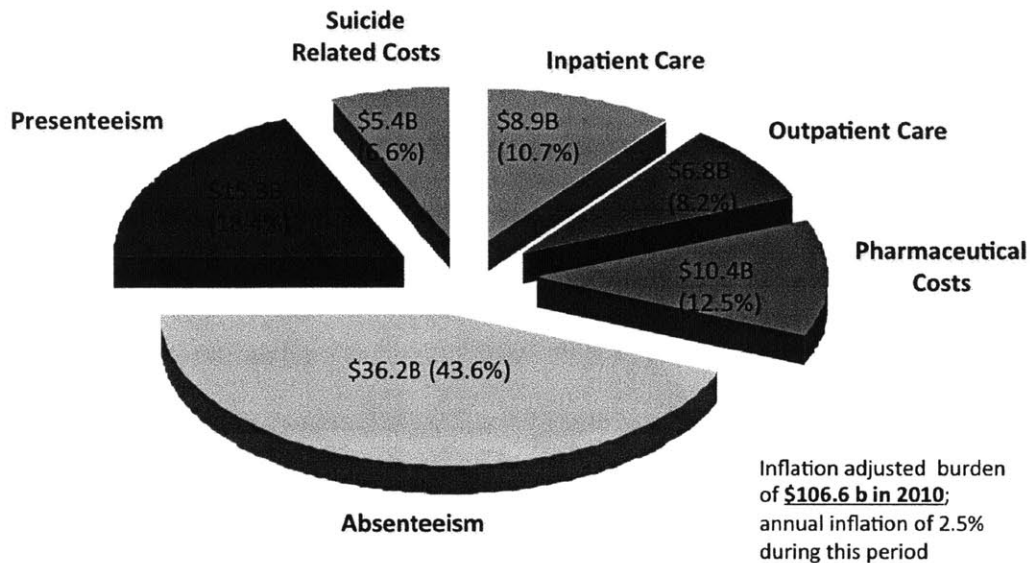
From the perspective of employers, employees with co-morbid depression or those with other stress-induced anxiety often develop more severe physical manifestations. This phenomenon is known as somatization; a natural mind/body process in which emotional distress manifests as physical symptoms (e.g., blushing, palpitations, chest pain).

The combination of co-morbid depression and somatization leads to significant impact on productivity in terms of increased absenteeism, presenteeism (which is the tendency to over-work when sick, leading to less productivity) and overall sub-standard quality of the work delivered. Fig 8 clearly shows the significance of the the costs associated due to depression in the workforce and the related costs that an employer would have to bear in terms of reduced productivity and in higher medical insurance costs for a self-insured employer¹.

¹ Self-insured employers are those who bear the burden of medical insurance for their employees by risk pooling.

Economic Burden of Depression, 2000

\$83.1 Billion



51

Fig 8: Economic Burden of Depression

Source: Greenberg PE, et al. *J Clin Psychiatry*. 2004;64:12.

2. Adolescent Depression and Student Mental Health

Demand for mental health services in colleges is rapidly rising. A recent survey by American College Health Association (ACHA) shows 25% of the 11 million students in 4-year institutions in the US are affected by mental health conditions.

Students affected with behavioral health issues

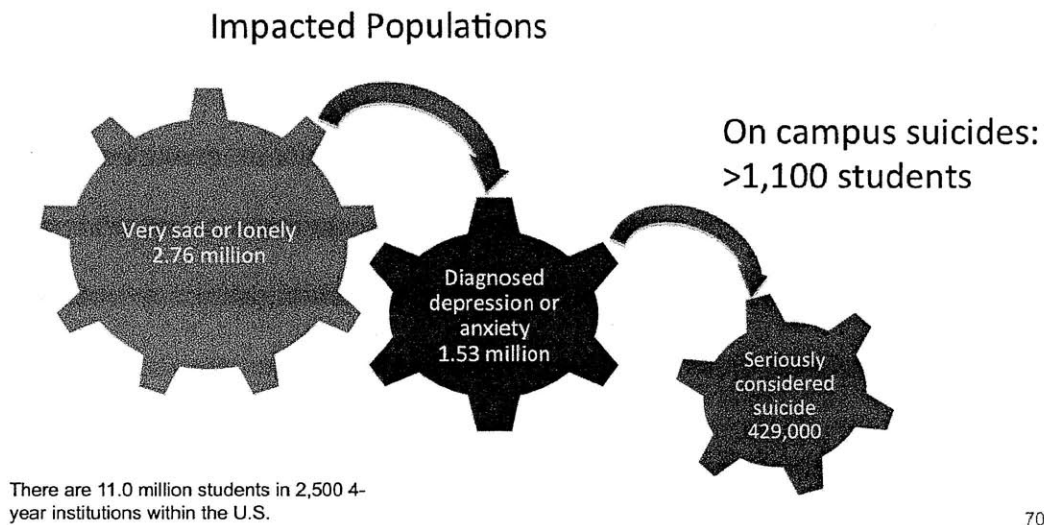


Fig 9: Number of students affected with behavioral health issues in the US

Source: ACHA National College Health Assessment, 2010

Such an unprecedented rise in the number of students seeking counseling or other treatment also impacts the demand on the student health centers. In the National College Health Assessment of 2008, 30% of college students considered “seeking help from a professional if they were having problems that really bothered them.” This proportion of students seeking help results in overwhelming the mental health services at educational institutions. Fig 10 shows the tilting of the balance of demand and supply in the student health system.

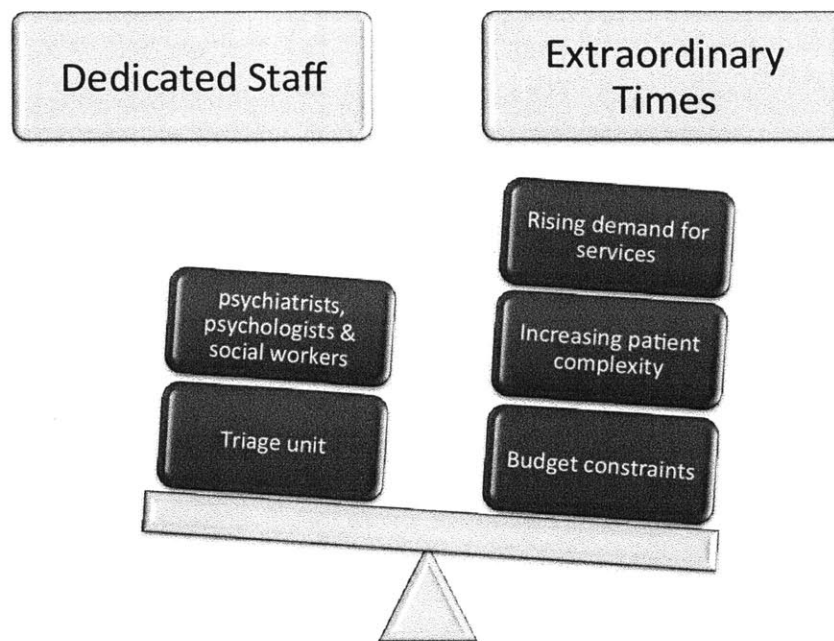


Fig 10: Demand and supply imbalance - student health services at educational institutions

This imbalance is created mostly by the budget restrictions, the rising number of students that are seeking services and the complexity of the cases that leads to additional interventions.

4.4 Relevant Market Segments

Considering the target applications the most valuable market segments were determined to be integrated healthcare networks (IHN) and student health - educational institutions. In this case study we are focusing on IHN's.

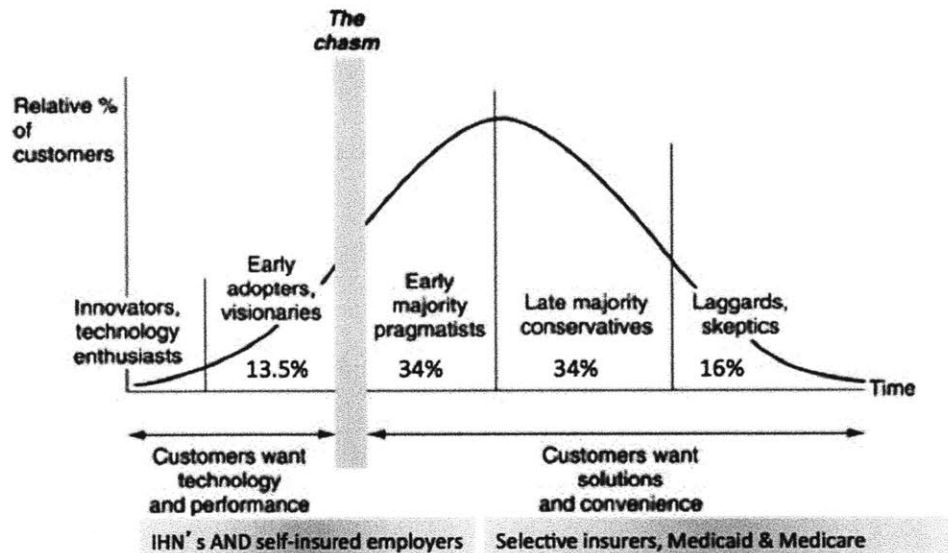
Integrated Healthcare Networks (IHN)

IHN's are a managed care system in the United States that includes a hospital organization that provides acute patient care, a multispecialty medical care

delivery system, the capability of contracting for any other needed services, and a payer (Medical Dictionary). Geisinger Health System in Pennsylvania or the Henry Ford Health System in Michigan are some examples of major and well known IHN's.

Geoffrey Moore evolved Everett Roger's diffusion of innovations theory to expound more on the granularity of technology adoption in his book "Crossing the Chasm". He categorized the adoption cycle into five segments. As we see in Fig 8, the chasm accordingly exists between the early adopters of technology and the early majority pragmatists and for a new technology commercialization is the greatest challenge. If we map IHN's and self-insured employers into this model, we see that they are spread across the first three segments of this adoption cycle. There are those such as Children's Hospital Boston or Kaiser Permanente are using and innovating path breaking health technologies for providers and patients in several areas. At the same time there are others who have just adopted or those who have opened up towards adapting or enhancing current innovations to their needs. The trend among IHN's and self insured employers is clearly towards crossing this chasm with the use of technologies that support their cost reduction goals. Care models such as Patient Centered Medical Homes (PCMH) and Accountable Care Organizations (ACO) whose targets are to reduce healthcare costs with better collaboration between the member organizations dictate that technologies are used for goals that include patient communication, decision support, clinical and financial data analytics.

These models, in spite of their challenges in finding greater acceptance are paving the way for providers to adopt technologies that reduce cost, increase access, quality and safety, as well providing better patient satisfaction.



Source: <http://thesirevolution.files.wordpress.com/2009/02/chasm.jpg>

Fig 11: Crossing the chasm

4.5 Value Proposition

IHN's typically serve as providers, payers and self-insured employers. The value proposition from them from Veritas' solution is relevant for all three aspects of their identity.

The scale of patients served, the willingness of these IHN's to integrate health technology systems offer them significant cost and operational benefits as payers and providers. In addition, the ability to maximize the ROI for Veritas were the

primary factors that led to making IHN's the key market segment for the go-to-market strategy.

Veritas' system of technology based patient assessment, clinical decision support and patient communication using a stepped care serves model reduces cost and increase operational efficiencies for the IHN's.

4.6 Commercialization Analysis for the Product

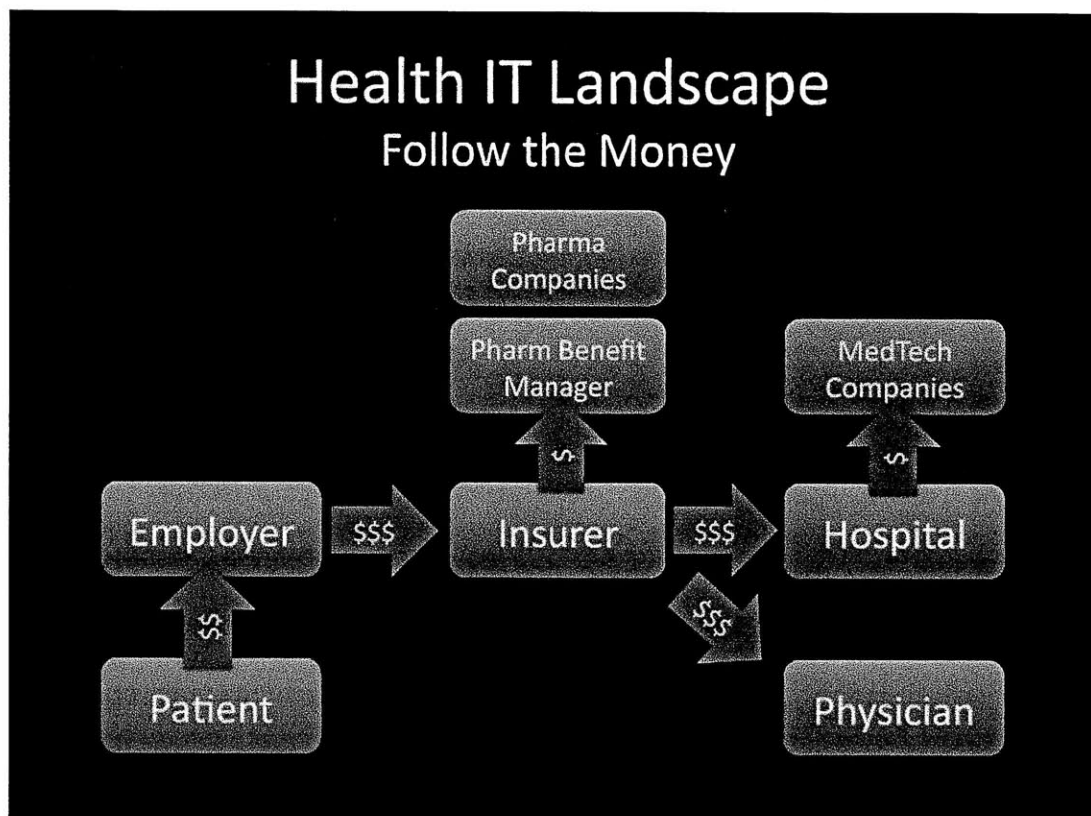


Fig 12: Flow of Money in the Health IT Landscape

Source: Zen Chu, MIT Entrepreneurship Center (Chu)

Bringing the product to market and devising the go-to-market process in an environment with multiple stakeholders is much streamlined once the flow of money is investigated. Fig 12 shows this flow in Health IT. For Veritas, the eventual beneficiaries as buyers are payers (private insurance companies, self-insured employers) and providers. As users the beneficiaries are patients and providers. From a go-to-market standpoint the following decision making strategy was generally applied:

- 1.) Payers and providers that are technology conscious, and
- 2.) Whose needs match Veritas' value proposition closely and who could derive maximum benefit from the product.
- 3.) Customers who represent a large market. This would be an efficient method for Veritas to reach their volume and future profitability targets

A thorough financial analysis was done, which consisted of determining the market size of patients with co-morbid depression, and scoping it to those who fit the following filter:

- 1.) Insured
- 2.) Adults (> 25 years old)
- 3.) Fall into these market segments:
 - a.) Patients with 2+ chronic conditions AND mood disorders, depression plus anxiety OR anxiety alone

- b.) Patients with primary mood disorders, depression + anxiety OR anxiety alone
- c.) Chronic pain (migraines or low back pain)

After taking into account realistic figures, that included factors such as patients refusing treatment and patients not detected by screening, an addressable market of about 62 million patients was realized.

Once an addressable market was known, a few sample case studies with IHC's made it possible to create the revenue forecast. To make this estimation the pricing structure included software licensing, implementation, customer support and maintenance charges.

4.6.1 Determining the Economic Value to the Customer (EVC)

This was an essential step towards finding the right price point/s and for creating a coherent marketing pitch for the customer.

In order to calculate the EVC, the key was to calculate the cost avoidance with Veritas' system as compared to what they were presently incurring. To do this the cost avoidance was calculated for each of the three market segments.

The total cost avoidance for each segment involved determining the a.) cost of Veritas' product – b.) cost avoidance attributed to the use of the product.

For determining b.) the number of patients that would be given care by physician (MD's) versus those given by others in the trained clinical staff for behavioral therapy (such as PhD or Master trained nurses or assistants) and through technology assisted therapy was multiplied with the reimbursement rates for each type. This was then compared to the current proportion of care given by MD's and other clinical staff.

Since the reimbursement rate for MD's is higher than the other clinical staff and acknowledging the fact that a higher proportion of insured's would get moved to non-MD's owing to Veritas' stepped care model, there is a clearly realizable cost benefit for the IHC's. The EVC was instrumental in showcasing the value of the product.

In the final profitability analysis spanning five years, a practicable adoption rate within the addressable market taking in conjunction with the pricing and cost for Veritas showed a profitable business opportunity in this time span. Growth estimates year-to-year assumed growth in the number of patients cared for per customer plus the growth in the number of customers added.

5 Future Potential: Adoption, Regulation and Beyond

With the explosion of healthcare technological solutions and companies, there is an expansion in offerings and entrepreneurial activity. It is hard not to draw parallels between the explosion of the auto industry in the US, in the later part of the 19th century when they were about 2000 firms to the 3 major ones in span of the next 40 years. The health technology industry is bound to see consolidation in the number of players as well as integration in the channels of communication, means of data generation and analysis as well that for providing coordinated care.

5.1 Consumer Focused Health Innovations and Their Adoption Dynamics

Tracking prescription medication adherence, knowing the reasons, and encouraging increased patient compliance through creative incentives is now closely tied to the latest health technology innovations and care models.

The shift from an enterprise centric, health focused mindset to a consumer focused, lifestyle and wellness centric one will make a big difference in how patient care is managed. That said, from a consumer or patient perspective the experience for them is most valuable and hassle-free when their interactions with the technology systems are well integrated with their lifestyle goals, their

communications with the provider, and the insights they want to gain from their activities, be they related to medication or lifestyle.

Such seamless integrated solutions give added value when their data can easily be shared from one provider to the other or from one technology platform to another. With the market opportunity for such systems abound, we are still in the early but exciting stage of healthcare technology innovation, in which we have adopters who come by choice and those are pulled into it. Fig 10 shows an overview of the market reality with how a user type fits with the scale of adoption of health technology.

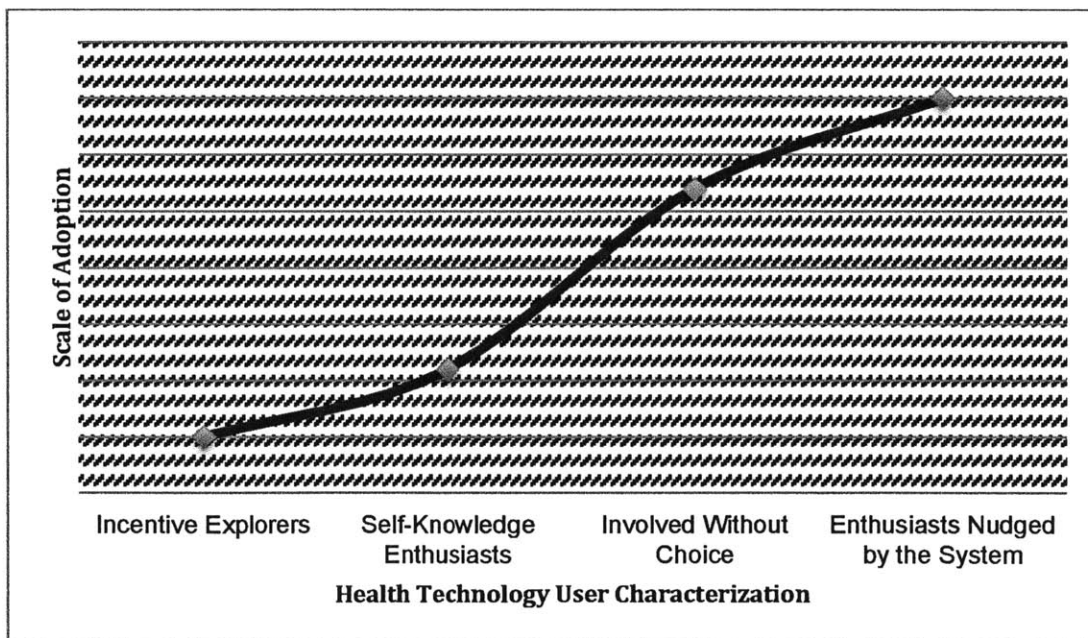


Fig 10: How adoption varies with health technology user type

Fig 10 shows that the “self-knowledge enthusiasts” and to some extent “incentive explorers” are the ones who would be or are the early adopters and are, in one

way, the marketers of such technologies. That said, it is the other two “Involved Without Choice and ”Enthusiasts Nudged by the System” who make up the bulk of the adopters. From a perspective of disruption, “Self-knowledge enthusiasts” are the one whose advocacy and passion will make the providers and payers to take a hard look into changing their care and reimbursement models that will jumpstart these newer innovations in health technology.

From a consumer perspective then, it is very important to see who adopts these systems and why, at the same time estimating how it would help change the current effort in tackling the healthcare cost, access, safety and quality related issues.

Let us take the example of “Quantified Self” (QS); a movement to incorporate technology to acquire data about an individual’s daily activities, such as sleep, food, mood, environment etc. Their initiative started with the aim to have “a collaboration of users and tool makers who share(d) an interest in self knowledge through self-tracking”. QS users are signed-up to the basis that this data gathering is done with simple non-intrusive methods, such as through sensors, devices and mobile applications. The users main interest is to be able to look at data in ways that provides them self-discovery insights that are novel. At the same time they also want to know what to do to influence their measurements and scores. An example of this would be the Basis heart rate monitor that is embedded in a watch. It offers analytical tools that motivate users to make

changes when required, such as a possible heart rate increase at a stoplight that causes road rage. Although QS provides great user value, it is still at the leading edge of healthcare innovation on the consumer side, with adopters who fall into a very narrow market segment. There are several such innovations on the patient engagement side in which the main driver of adoption is the consumers' own motivation for self-improvement. While there are others such as Numera|Social that we discussed in section 3.2.1 where social network and gamification is used, their adoption is driven by clear incentives and encouragement by those who have clear stake in seeing increased adoption, such as self-insured employers who aim to reduce cost.

5.2 Adoption Considerations for Mobile Platforms

The increasing adoption of smartphones and tablets, their ubiquity and value they provide to the user makes mobile healthcare applications one of the dominant modes for achieving the objectives of the stakeholders. But this also brings about the issue of relevance and participation rates. The actual value proposition and utilization depend a lot on the market segments that these are applicable to.

According to a study done by Chilmark Research (Moore, 2012) that in the market, mHealth application developers struggle to sign on users, especially those that have chronic conditions, to consistently use their application. It mentions that whenever it has become successful, it has been due to the

continuous feedback received by the users from the clinical side. The success of a mobile application then rests partly on who deploys the application.

Also, some other examples of applicability would include those where mHealth apps designed for smartphones may not be able to track patient information for seniors as well have them communicate with their providers due to the lesser adoption of smartphones in this segment. Tablets apps such as those for iPads may be more suitable for them. In the case of drawing insights from prescription drug use among demographics with very limited use of Internet, technology solutions or simple feature-phone SMS would provide means of communication. Also, having a Facebook application for wellness program may not be suitable for the older generation of employees who may not be able to draw upon the advantage it offers of a larger network due to generational preferences.

5.3 Adoption From the Provider's Point of View

In any health technology adoption from a provider's point of view, when they are tight on schedules and set with their workflow, any new addition of tool(s) is not considered without a proper value proposition with its quantified efficacy and also the possibilities for reimbursement. When the current reimbursement models do not quite support things such as patient communication using mobile applications, it creates a situation where innovations and entrepreneurial activity in this area is looked at with a lot of suspicion by investors and could lead to lesser commercialization of innovations. The possible way out this is the payment

model: one from a fee for service delivered in a hospital or clinical setting to that which is based value-based outcomes where the patient is an active contributor in their own care.

In either case, careful consideration ought to be given to the choices made in deciding the platform, channel or technology used to cater to the diversity in the market. A combination of these may prove to be a solution although its practicability is eventually decided by the speed and scale of benefits for the stakeholders involved.

5.4 Regulatory Considerations

Since the healthcare technology that includes software and devices at the meeting point of providing care, diagnosis and the patient, federal regulation, especially by the US Food and Drug Administration (FDA), becomes a very important factor in bringing the innovations into the market with due consideration given to patient safety.

Since the traditional technology industry is regulated primarily by the standards set by industry consortia, where they compete based on these standards and their strategies, the entry of novel technologies or patient procedures into the healthcare space is faced by a mindset clash. This is because the responsibility of their products and services on the wellbeing of the individuals they are intended to serve is not observed when they - for example - market a product that facilitates data collaboration in the cloud. This can be perceived as a burden

when commercializing health technology products, which, based on market analysis, exhibit tremendous business opportunity but have regulation barriers that are not expected in the hi-tech industry.

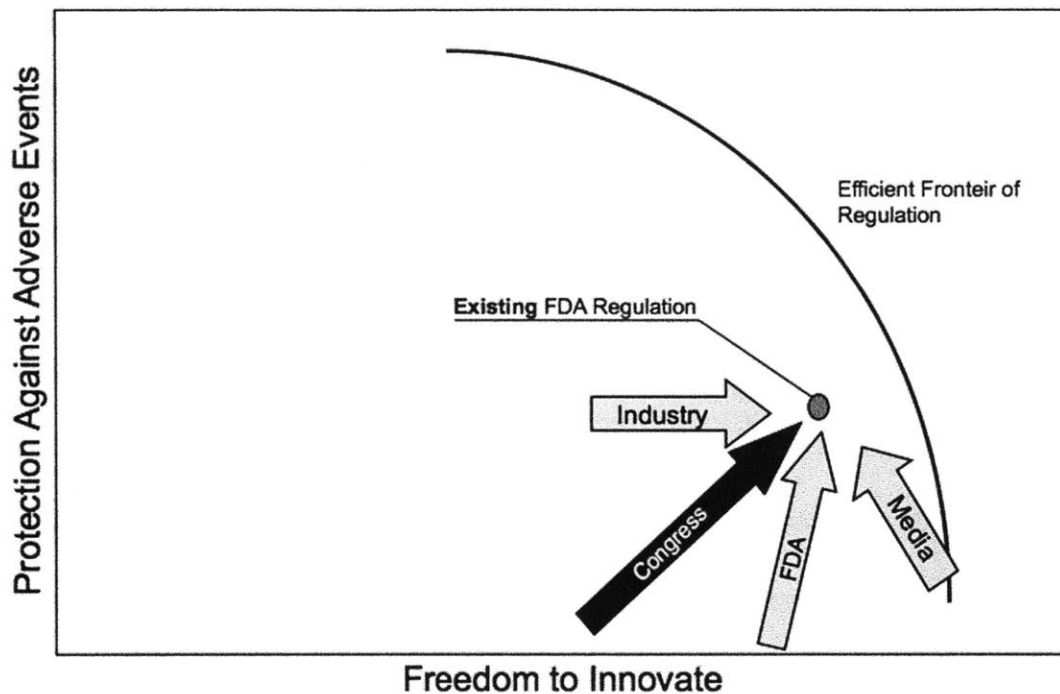


Fig 11: Innovation vs Regulation Forces

Source: MobiHealthNews (Thompson, 2012)

The FDA could regulate within its mission to protect safety of individuals and at the same time encourage innovation to promote overall public health. From an entrepreneurial standpoint, the passion of bettering public health, gaining insights and realizing market opportunity could be stymied by overbearing regulation. The regulation is not only a clearance to market (pre-market clearance) the products but also how they are marketed and advertised. Here, established companies

who have systems in place and experience in bringing health technology products to the market gain an upper hand.

Fig 11 gives a graphical representation of these seemingly opposing interests between the freedom to innovate and FDA mission to protect against adverse events. The ideal position would be at the top right corner of this chart. There are essentially four force that are guiding where existing federal regulation are placed. Congress and the FDA are essentially the primary forces that steer the point. This point may change with greater acceptance and proven outcomes and safety of the products regulated, as well as well as the competitive nature of the players within this industry.

The range of health technologies and the media used, from mobile Health to home diagnostic devices (some of them interfaced with a mobile device) and their interconnectedness with enterprise HIT systems makes regulation of these systems complex. For example, take the case of when a blood glucose meter is connected to a cell phone that is then connected to a server and a PC in the doctor's office. When something goes wrong and an erroneous result is displayed on the doctor's monitor, it is difficult to point out clearly which component manufacturer has the post-market obligations to report the so-called adverse event to the FDA (Thompson, 2012). There need to be clear guidelines to figure out who and how to investigate and point out the responsible entities.

All in all, it is a great learning process for the players – the regulators, industry,

and product users – as to how to navigate this space of seeming conflict. The best possible way out of this would be high-level collaboration among these players. Industry bodies such as mHealth Regulatory Coalition that provide consensus and a single voice to the FDA are examples of this collaboration. Greater participation by the consumers and investors in this consensus building and working with the regulators will only make the process easier. Learning from past experiences of new product ecosystems and how they were efficiently regulated (such as green products by the Environmental Protection Agency) as well from how health technology is regulated around the world seem promising ways of making regulation in healthcare technology reach the golden point.

5.5 What Next: From a Body Centric Healthcare Perspective to Beyond?

The focus here was on the healthcare technologies and patient engagement primarily in the US. It is clear that people are becoming more aware about their health and well-being. Yoga and meditation was not in the mainstream 30-40 years ago, but as things evolve, people are becoming increasingly conscious about their lifestyle choices. The combination of this technology-enabled trend and of an environment where payers, providers, pharmaceutical companies and healthcare innovators want this health-aware mindset for increasing their value, is overall a very good situation for the individual. It allows the individual to explore the depths of their being from a body centric one to one that involves the mind, intellect, memory, ego and consciousness complex and realize greater truths of human existence.

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